Transportation Authority of Marin

Highway 101 Greenbrae Corridor

TAMALPAIS DRIVE INTERCHANGE PLANNING STUDY

Version 2, January 2007

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SUBMITTED BY: _____ January 25, 2007
Matt Htoo, PE - Carter & Burgess Date

REVIEWED BY: _____ January 25, 2007
Kai Chan, PE, PMP - Carter & Burgess Date

APPROVED BY: _____ January 25, 2007
Dina Potter, PE - Carter & Burgess Date

Carter Burgess

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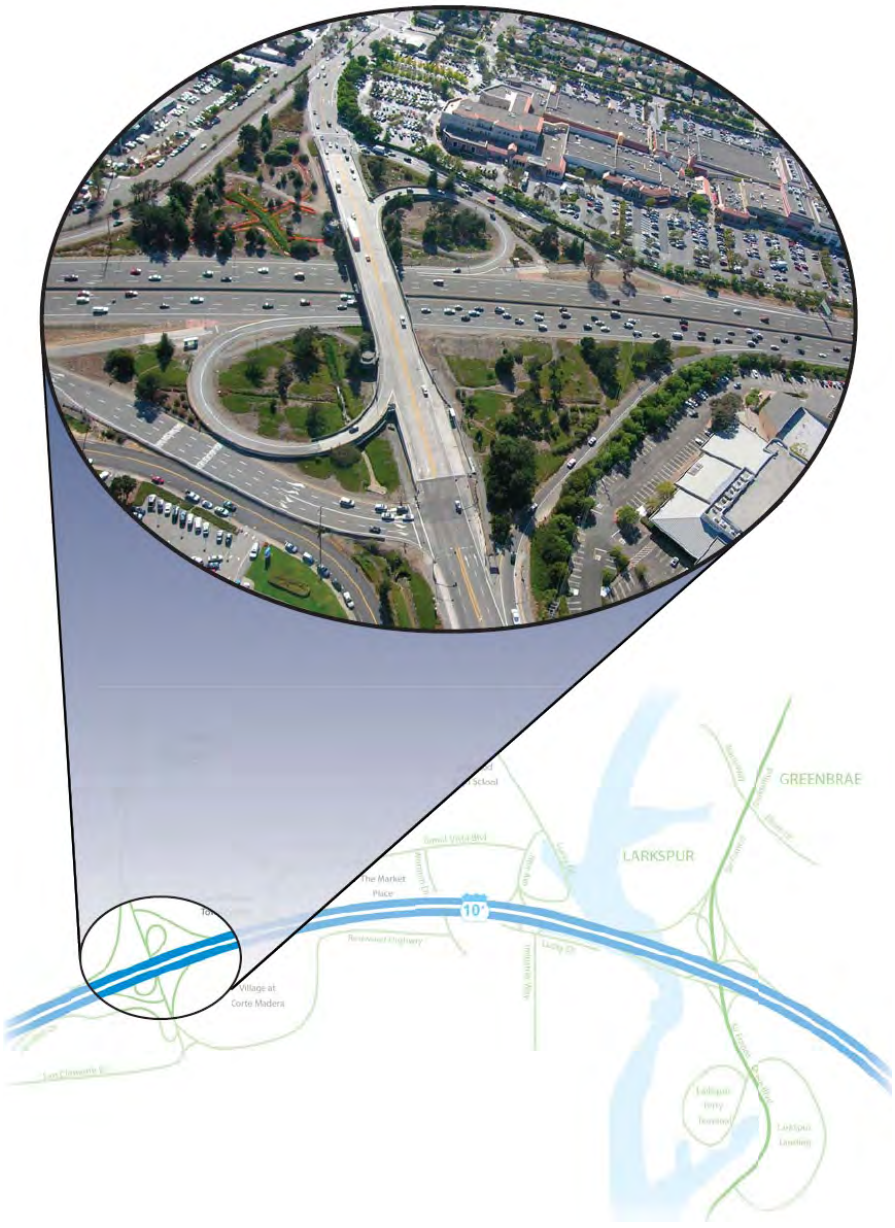
1. Introduction

As part of the Greenbrae Corridor Project, input was received from various project stakeholders and collected at a Public Workshop on October 24, 2006 regarding traffic operations, interchange design, pedestrian, and bicycle issues within the US 101 corridor and at the Tamalpais Drive Interchange. Several studies have been done to assess improvements at this interchange, the latest is the October 2006 study completed by CH2M Hill for the Town of Corte Madera. The engineering assessment done and summarized in this planning study was performed independently of the CH2M Hill studies and included meetings with engineering managers from the Town of Corte Madera, City of Larkspur, Transportation Authority of Marin (TAM) and Caltrans. Input from these key engineering managers was used to refine the design options presented in this report.



This report is intended to serve as a resource to help TAM during the development of the Greenbrae Corridor Project. Much of the traffic, transit, pedestrian, and bicycle data were generated and collected as part of the Greenbrae Corridor Project. The proposed Tamalpais Drive Interchange improvements in this report consist of planning level studies. Additional engineering and environmental studies are required to implement these improvements.

Four design options, divided into Realignment/Intersection Modification and Interchange Modification options, have been identified that would address the concerns received from project stakeholders. The Realignment/Intersection Modification options could be implemented in a shorter time and are small enough that funding may be available in the next five years. The Interchange Modification options are much larger in construction size, have a longer project development process, and require a larger financial investment. The objectives of these improvements include:

- Improving the interchange to address future traffic volumes
- Improving freeway ramp operations
- Improving local street circulations and operations
- Improving bicyclist and pedestrian safety
- Improving transit access and usage
- Reducing future maintenance at the interchange

2. Site Description and Existing Conditions

The Tamalpais Drive Interchange is located on US 101, in Marin County. US 101 is a primary north-south multimodal transportation corridor for Marin County and the North Bay, and is a critical link in the Bay Area's regional transportation system. This freeway is the only continuous, high-capacity, north-south highway serving Marin and Sonoma counties north of the Golden Gate Bridge.

The Tamalpais Drive interchange is approximately 7.5 miles north of the Golden Gate Bridge. The basic physical design for this interchange is a conventional, partial-cloverleaf on-ramp configuration, with a Tamalpais Drive Overcrossing structure which provides a key west to east crossing, over the freeway, for local traffic in the Town of Corte Madera and the City of Larkspur. Caltrans' 2004 Freeway Ramp Traffic Volumes indicate that this interchange is one of the busiest interchanges in Marin County, with over 50,000 vehicles per day entering and exiting US 101 via this interchange. Cumulative forecast volumes based on the Draft Corte Madera General Plan reveal that critical ramp volumes in this interchange area are projected to increase by 10% to 30% by 2030.

To the north of the Tamalpais Drive Interchange, approximately 1.4 miles, is the Greenbrae Interchange which provides access to Sir Francis Drake Boulevard, and approximately 1.6 mile to the south is the East Blithedale Avenue/Tiburon Boulevard Interchange.

3. Tamalpais Drive

Tamalpais Drive is one of the busiest arterial roadways in Marin County, and is a designated bicycle route. It is a four-lane road throughout the interchange area. Signalized freeway ramp and street intersections are spaced at approximately 900 feet which is more than the preferable distance of 600 feet required by Caltrans design standards. The average distance between off-ramp intersections and loop on-ramps, however, is only 200 feet. This causes on-ramp entrances to be frequently blocked by stopped traffic during the red cycle of the signals ahead, especially during peak hours. In addition, the profile of Tamalpais Drive is on a crest vertical curve which reduces the vertical stopping sight distance for vehicles traveling over the freeway and stopping at the ramp intersections. On the west side of the freeway, on Tamalpais Drive, there are three signalized intersections within 700 feet.

On the west side of US 101, the signal phasing at the Tamalpais Drive/Madera Boulevard intersection uses a 120-second cycle due to the close proximity of this intersection with the intersections of Casa Buena Drive, Sanford Street and Meadowsweet Drive. This long signal phasing cycle is the primary cause of daily traffic queues on Tamalpais Drive during peak hours.

On the east side of US 101, the spacing between two signalized intersections, one at the northbound off-ramp/Tamalpais Drive intersection and the other at the San Clemente/Tamalpais Drive intersection is about 400 feet apart. The T-intersection at Paradise Drive/Tamalpais Drive has a separate right-turn only dedicated lane that is controlled by a stop sign and is only about 150 feet away from the San Clemente/Tamalpais Drive intersection. This short distance between these two intersections and heavy traffic volumes on Tamalpais Drive contribute significantly to traffic turbulence during peak hours.

4. Traffic Circulation

4.1. Traffic Operations

At the Tamalpais Drive Interchange, the vehicular traffic generally operates well with minimal delays during peak hours. The average delay at each intersection is generally less than 30 seconds per vehicle. However, during peak holiday periods in December, substantially higher traffic levels and increased delay can occur in the interchange area. Future traffic levels may increase to a point where additional interchange improvements will be desirable to improve traffic flow and minimize delays to vehicles and buses traveling along Tamalpais Drive.

Key traffic operations issues include:

- Numerous closely-spaced intersections along Tamalpais Drive at US 101
- Heavy PM peak hour northbound off-ramp traffic (Currently about 1400 vehicles per hour and expected to increase by 200-500 vehicles per hour under future conditions)
- Moderately heavy AM and PM peak hour southbound off-ramp traffic (Currently about 900 vehicles per hour and expected to increase by 150 to 200 vehicles per hour under future conditions)
- Long signal cycle length at Tamalpais Drive/Madera Boulevard intersection creates challenging signal coordination issues
- Unconventional intersection layout at San Clemente Drive/Tamalpais Drive intersection

4.2. Future Traffic Operations

Future traffic conditions in the Tamalpais Interchange area are in many ways related to the type and intensity of development near the interchange. The Draft Corte Madera General Plan, released in October 2004, contemplates increases in the development potential of several areas around the interchange, including the Corte Madera Town Center and Village at Corte Madera shopping centers. Should little or no new land use changes occur in the next 20 years in Corte Madera, traffic levels in the interchange area will increase by approximately 20% due to changes in regional travel pattern and growth outside of Corte Madera. The interchange would generally continue to operate with moderate delays, with some improvements necessary to improve traffic progression and minimize delays.

If additional land use changes do occur in the interchange area, traffic levels in the interchange area may increase by approximately 25-50% over existing levels, depending on the type, location, and intensity of development. Additional traffic may result in the need for improvements to maintain acceptable traffic operations in the interchange area. With future traffic increases, the critical capacity constraint points will be the northbound US-101 Off-Ramp / Tamalpais Drive, the Tamalpais Drive / Madera Boulevard, and the Tamalpais Drive / San Clemente Drive intersections. However, any vehicle capacity improvements at these locations will need to be balanced with travel needs for bicyclists, pedestrians, and transit vehicles as well as the Corte Madera General Plan's policies emphasizing quality of life and small town character.

5. Traffic Safety

Based on a review of accident data, the traffic safety at the Tamalpais Drive interchange has improved over the past five years. Prior to that, a disproportionately high number of rear-end collisions occurred along the Tamalpais Drive Overcrossing due to traffic congestion, the limited vertical stopping sight distance on Tamalpais Drive, and curvature of the roadway. Also, due to

highly variable traffic volumes, it is extremely difficult to optimize signal timing with the traffic demands at the intersection. To address these issues, in 2001 the Town of Corte Madera worked with Caltrans traffic engineers to synchronize and re-time the signals at the intersections along Tamalpais Drive. A review of collisions from the years 2001 to 2005 indicates that the Tamalpais Drive interchange now experiences a collision rate comparable to statewide averages.

With the likely increase in future traffic at this interchange, there will be a need to consider safety improvements along with operational improvements, as collision rates are often times correlated with traffic volumes on local streets and freeway ramps.

6. Pedestrian and Bicycle Circulation

Bicycle and pedestrian circulation in this interchange area is an important component of County transportation plans. All the improvement options presented in this report will improve non-motorized access and connections to other bike and pedestrian trails or paths.

6.1. Bicycle Circulation and Safety

For bicyclists and pedestrians, Tamalpais Drive is the only opportunity to cross US 101 between Tiburon Boulevard and Wornum Drive. It serves a vital link between the Bay Trail east of US 101 and other cycling destinations to the west, including local schools, downtown Corte Madera, downtown Larkspur, and regional bicycling routes along Camino Alto Drive and Magnolia Avenue.

A wide shoulder currently exists on Tamalpais Drive over US 101, but it is neither well maintained nor striped as a designated bike lane. Moderately high traffic volumes access US 101 via the cloverleaf loop ramps, which conflict with bicyclists traveling in the shoulder. Bicyclists are further challenged by high vehicle speeds and motorists' limited sight line due to the vertical curvature over the crest of the interchange. There were four reported bicycle collisions with motorists along Tamalpais Drive from Madera Boulevard to Paradise Drive between 2001 and 2005. Despite these issues, Tamalpais Drive is popular with bicyclists, especially weekend recreational riders.

Potential safety and access improvements for bicyclists could focus on:

- Tightening curves for diagonal freeway on-ramps to reduce vehicle turning speeds and increase bicyclist visibility at ramp crossings.
- Adding bicycle lanes and more clearly delineating the bicycle right of way across the Tamalpais Drive interchange. This could be accomplished by enhancing intersection striping and adding pavement coloring to inform motorists when they are crossing a bicycle facility.
- Improving bicycle route maintenance to keep roadway shoulders free of debris

- Improving intersection crossings, particularly where dedicated right-turn lanes and freeway ramps exist and at the San Clemente Drive/Tamalpais Drive intersection where bicyclists access the Bay Trail and bike lanes on San Clemente Drive.
- Adding loop detectors ant signalized intersections

6.2. Pedestrian Safety and Circulation

Sidewalks only exist along the south side of Tamalpais Drive crossing US 101. The sidewalk connects the Village at Corte Madera and Corte Madera Town Center shopping centers and other local destinations and provides access via spiral ramps to the bus stops at the interchange.

- The interchange is the only crossing between Wornum Drive to the north and Tiburon Boulevard to the south, a distance greater than two miles. The spiral ramps at the interchange and sidewalks are not compliant with the Americans with Disabilities Act (ADA) due to excessive grades.
- Each weekday, roughly 250 to 300 pedestrians use this intersection to access buses on either side of the highway. These pedestrians include Corte Madera residents commuting to San Francisco and out-of-area residents commuting to employment centers at The Village and The Town Center shopping centers on either side of US 101.
- During weekday peak hours, roughly 20 to 30 pedestrians per hour use the interchange to cross US 101. The Tamalpais Drive/ Madera Boulevard intersection also experiences high levels of pedestrian activity.
- Pedestrians accessing the bus pads currently must cross the cloverleaf ramps, where vehicles entering the highway are accelerating and have limited sight lines due to the curving ramp. There are no crosswalks and limited illumination. Improved access from the bus pads to the adjoining shopping centers may improve pedestrian safety and contribute to higher transit ridership
- From 2001 to 2005, there were three reported pedestrian collisions along Tamalpais Drive from Madera Boulevard to Paradise Drive

Potential safety and access improvements for pedestrians could focus on:

- Tightening curves for diagonal freeway on-ramps to reduce vehicle turning speeds and increase pedestrian visibility at ramp crossings.
- Improving access to and from the bus stops along US 101 by striping crossings across the loop ramps in the short term and relocating the bus stops to a more accessible location in the long term.
- Adding a concrete barrier dividing the traveled way and the sidewalk on the south side of the overcrossing and adding a north sidewalk across the interchange.

- Improving safety at intersection crossings by clearly marking crosswalks with high visibility striping.

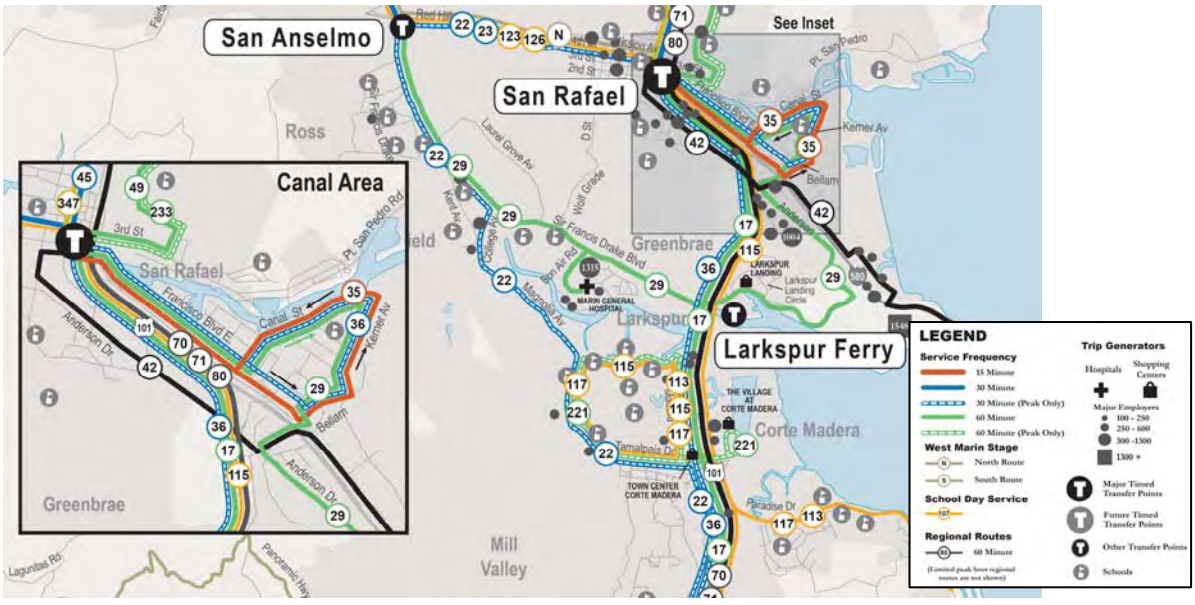
7. Transit Service and Accessibility

Golden Gate Transit (GGT) operates public bus service within Marin County and to San Francisco. The Marin trunk lines, Routes 70 and 80, operate along US 101 and stop at the Paradise Drive bus pads underneath the interchange. The Marin County Transit District (MCTD) also operates a new community bus service, Route 221, along Tamalpais Drive between Corte Madera and Larkspur.

Improved transit service options are needed to address travel needs and to counter adverse traffic congestion impacts on travelers and communities. Golden Gate Transit runs freeway express bus services along US 101 with passenger access/egress at bus pads near ramps, including the Paradise Drive pads at this interchange. About 270 to 300 bus passengers use these stops each day, making them the most-utilized stops in Corte Madera. Buses traveling along Tamalpais Drive stop at the Corte Madera Town Center on Tamalpais Drive at Madera Boulevard and at a westbound stop on the east side of the overpass.

While the Marin County Transit District has no immediate plans to run bus rapid transit service in HOV lanes, this is a potential long-term strategy mentioned in the Metropolitan Transportation Commission's *Bay Area Transportation Blueprint*. Bus service along US 101 and Larkspur Ferry connections are important elements to encourage a shift to transit.

All options proposed in this study enable and maintain existing transit connections. With Interchange Modification - Option B, the reconstruction of the interchange would allow opportunities to move the bus pad to locations that may better serve pedestrians and cyclists.



8. Interchange Maintenance

Review of geotechnical information revealed that the roadway approach to the Tamalpais Interchange Overcrossing rests on fill over Bay Mud. Because the structure foundation is on piles and the roadway is on Bay Mud, settlement at the roadway conform to the overcrossing structure continues to occur due to the weight of the embankment. Roadway surface deterioration due to grade differentials and cracking has required frequent maintenance by the Town of Corte Madera.

One possible solution may be to re-construct the fill, over excavate the material under the fill, and backfill with light weight fill. This solution would require reconstruction of the embankment, under traffic, and may be best done when there is funding to replace the entire interchange.

9. Improvement Recommendations

After reviewing and developing various options, two Realignment/Intersection Modification options and two Interchange Modification options were identified that would address traffic operational concerns, traffic congestion issues, and pedestrians and bicyclist safety. Each option is briefly described below and is shown in plans following this summary. In all options the following is proposed:

- The Tamalpais Drive/Paradise Drive T-intersection is to be modified to allow for ingress from Tamalpais Drive to Paradise Drive only. Paradise Drive would be a one-way street at the T-intersection.
- A new 40-foot wide two-lane connector road (includes curb parking) between Paradise Drive and San Clemente Drive is to be built through the corridor between two commercial properties.
- The Tamalpais Drive/ San Clemente Drive intersection would be improved. One option is to convert the intersection to a roundabout intersection design, and the other is to maintain the T-intersection but to add a dedicated eastbound Tamalpais Drive right turn lane to San Clemente Drive while improving pedestrian/bicycle crossings.
- The existing eastbound right-turn only dedicated lane at San Clemente Drive is to be reconfigured to improve pedestrian and bicycle access to and from the Bay Trail.
- The south approach to the Tamalpais Drive/Madera Intersection is to be reconfigured, which would allow for north-south overlap signal phasing and permit signal cycle lengths to be reduced and be better coordinated with intersections to the east.
- The Casa Buena Street connection to Madera Boulevard is to be relocated to connect to Meadowsweet Drive. Some private right of way will be required. However, there is an opportunity to do a right of way exchange with the property owner to facilitate the new Casa Buena Drive connection to Meadowsweet Drive.

9.1. Realignment/Intersection Modification - Option A

Build traffic roundabouts at the Tamalpais Drive/San Clemente Drive intersection, modify on-ramp intersections, and re-stripe to provide for bicycle lane on the overcrossing.

To reduce accidents and efficiently service traffic flow, many metropolitan areas in the United States and around the world are reintroducing traffic roundabouts at busy intersections where there is sufficient right of way to maximize intersection capacity. In June 2000, the Federal Highway Administration issued *Roundabouts: An Informational Guide (FHWA-RD-00-067)* which addresses the methodology, design principles, and standards in consideration for all modes of travel. A properly designed roundabout with two-lane approach has a capacity to carry 3,500 to 4,000 vehicles per hour. This option proposes to build traffic roundabouts with two-lane approaches at the existing intersection on Tamalpais Drive at San Clemente Drive as shown on the Realignment/Intersection Modification - Option A Plan.

This option also includes reconfiguring the diagonal on-ramps on Tamalpais such that the on-ramp diverges away from Tamalpais Drive at a ninety-degree angle. This will provide for improved bicycle and pedestrian visibility and accessibility. Improved pedestrian crossing treatments (i.e. high visibility) at intersections and ramps would also be included with this option.

In this option, the existing 12-foot wide traffic lanes on Tamalpais drive would be re-striped to 11-foot lanes and the existing four to five-foot wide painted median on the over-crossing structure would be reduced to a two-foot wide median. This would create a five-foot wide bicycle lane in each direction. The existing striping on Tamalpais Drive between the Corte Madera Town Center and US 101 southbound off-ramp would also be modified to accommodate these bicycle lanes.

A summary of this option includes the following:

- Convert the Tamalpais Drive/San Clement Drive intersection to a roundabout design
- Reconfigure the diagonal on-ramps to US 101 such that they diverge away from Tamalpais Drive at a ninety-degree angle
- Improve pedestrian crossing treatments at intersections and ramps
- Re-stripe lanes on the existing structure to allow for a five foot wide bicycle lane in each direction and a two foot wide median
- Add traffic control treatment such as colored bike lanes at the entrance to the loop on-ramp.

9.2. Realignment/Intersection Modification - Option B

Improve T-Intersection at Tamalpais Drive/San Clemente Drive intersection, modify on-ramp intersections, and re-stripe to provide for bicycle lane on the overcrossing.

Options B is identical to Option A except the intersection on Tamalpais Drive at San Clemente Drive would remain a T-intersection. To improve pedestrian and bicycle crossing at this intersection, the following would be done:

- Add signal activated electric illuminated pavement markers at the crosswalks.
- Modify the intersection to reconfigure the right-turn only dedicated lane, from Tamalpais Drive to San Clemente Drive with provisions to improve pedestrian/bicycle crossings.

9.3. Interchange Modification - Option A

Do minimum widening of the Tamalpais Drive Overcrossing to add dedicated right turn lanes for the US 101 loop ramps; reconfigure the ramp intersection to allow for left turn from Tamalpais Drive to the freeway the on-ramps.

This option could be the next phase of improvements that could be done to complement the improvements done under the Realignment/Intersection Modification, Option A or Option B.

This option would also include widening the Tamalpais Overcrossing on the north side and making the following improvements:

- Widen the overcrossing on the north side to add a dedicated right turn lanes leading into the loop ramps that serve the westbound Tamalpais Drive movement to southbound US 101. The widening would also shift all traffic lanes on the overcrossing to the north so that a concrete barrier may be added between the traveled way and the sidewalk on the south side of the overcrossing.
- Reconfigure the loop on-ramps to US 101 such that they diverge away from Tamalpais Drive at more of a ninety-degree angle
- Add bike lanes on both directions on the Tamalpais Drive Overcrossing.
- Widen the approach to the overcrossing and re-stripe traffic lanes as necessary to conform to the lane configuration on the overcrossing.
- Add sidewalk on the north side of the overcrossing
- Add concrete barrier between the traveled way and the pedestrian cross walk on the south side of the Overcrossing.
- The Tamalpais Drive/San Clement Drive intersection could also be converted to a roundabout design in this option or could be implemented prior to the interchange modification.

9.4. Interchange Modification - Option B

Rebuild the Tamalpais Drive Overcrossing and provide a wider cross section and convert the interchange into a split diamond interchange design.

This option could be the next phase of improvements that could be done to complement the improvements done under the Realignment/Intersection Modification, Option A or Option B.

Currently, approximately 500 vehicles per hour are using each loop on-ramp to enter US 101 from Tamalpais Drive during peak hours. The entrances at these two loop on-ramps are frequently blocked due to their close proximity with the signalized off-ramp intersections. In this option, both of the existing loop on-ramps would be removed. Tamalpais Drive traffic would make a left-turn to access the on-ramp to southbound US 101 on the west side of the freeway, and to access the on-ramp to northbound US 101 on the east side of the freeway.

This option would reconstruct the entire interchange and convert it to a split diamond interchange configuration and would provide the following improvements:

- A four lane Tamalpais Drive Overcrossing with dedicated double left turn lanes in the median that provides storage for traffic waiting to make a left turn into the on-ramp to southbound US 101 on the west side of the freeway, and to make a left turn into the on-ramp to northbound U S 101 on the east side of the freeway.
- Improved Tamalpais Drive profile. With the reconstruction of the overcrossing the profile may be adjusted to increase vertical stopping sight distance.
- Six foot wide bike lanes on both direction of Tamalpais Drive
- Pedestrian sidewalk on both sides of Tamalpais Drive meeting ADA requirements with a barrier separating the traveled way and the sidewalk
- Widened and modified off-ramps to provide storage and improved left turn and right turn movements into Tamalpais Drive.
- Relocated US 101 bus stops nearer to Town Center and Village shopping centers for better transit circulation and improved pedestrian and bicycle access
- The Tamalpais Drive/San Clement Drive intersection could also be converted to a roundabout design in this option or could be implemented prior to the interchange modification.

10. Conclusion

The options presented in this study are only preliminary and conceptual in nature. However, the options provide an opportunity for further dialogue among the various project stakeholders. Depending on funding, some of the improvements identified in this study may be implemented sooner than others.

Further engineering and environmental studies would need to be done to develop the improvements. These improvements will be presented at the next Greenbrae Corridor Public Workshop to obtain input from the project stakeholders to further:

- define and present candidate solutions to resolve the traffic congestions on US 101 and at the Tamalpais Drive interchange area and vicinity;
- obtain input from stakeholders regarding potential solutions;
- work to address critical issues, build a shared understanding, and create a consensus among the key stakeholders on a preferred solution.

The next page contains a summary table showing how each of the option addresses the improvement objectives.

	Realignment/Intersection Modification		Interchange Modification	
	Option A	Option B	Option A	Option B
Improvement Objectives	Roundabout Installation with Tightened Diagonal Freeway Ramps	Bicycle Lanes / Pedestrian Treatments	Ramp Reconfiguration - New Right Turn On-Ramps	Split Diamond Interchange Configuration with Ramp Reconfiguration
Improve interchange to address future traffic demands	✓	–	☆	☆
Improve freeway ramp operations	✓	○	☆	☆
Improve local street circulations and operations	☆	☆	☆	☆
Improve bicyclist and pedestrian safety	✓	✓	✓	☆
Improve transit access and usage	–	–	–	☆
Reduce future maintenance	✗	✗	✓	☆

☆ = **Meets objective** ✓ = **Partially addresses objective** – = **No significant change** ✗ = **Does not address objective**

11. Attachments

- Realignment/Intersection Modification - Option A Plan
- Realignment/Intersection Modification - Option B Plan
- Interchange Modification - Option A Plan
- Interchange Modification - Option B Plan